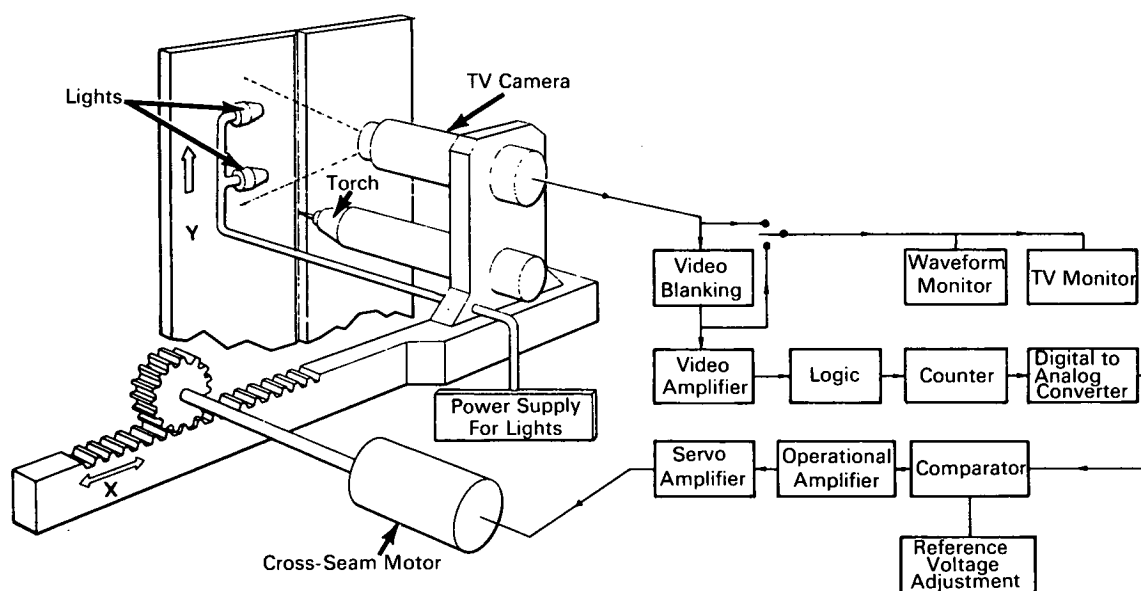


# NASA TECH BRIEF



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## Closed Circuit TV System Automatically Guides Welding Arc



A closed circuit television (CCTV) system, which has been developed in prototype form, will automatically guide a welding torch to position the welding arc accurately along weld seams. Digital counting and logic techniques are incorporated in the control circuitry to ensure performance reliability. Several commercially available welding systems with automatic arc guidance features have a number of disadvantages, which include limited applicability regarding the types of material to be welded, susceptibility to stray electrical signals, delicate setup, restricted field of view, or tendency to contaminate the weld seam. The CCTV system not only overcomes the deficiencies of these systems, but also has the added advantage of being able to track tack-welded joints. Many large, complex parts are now tack-welded prior to being subjected to

automatic welding, and this is when use of an effective automatic arc guidance system is highly desirable.

The basic CCTV welding arc guidance system is represented in the diagram. This system functions to maintain the welding arc on the weld seam as the area to be welded moves past the torch in the Y direction. The CCTV camera is mounted so that its axis is parallel to the axis of the torch; the camera is positioned so that the weld centerline runs horizontally, left to right, as viewed on the TV monitor. Since the weld seam centerline is parallel to the horizontal lines of the TV scan, the centerline image will mainly occupy only one scan line, as viewed on the TV monitor. Proper arrangement of lighting on the weld seam by two bright light sources will cause this video scan line to be much brighter than the other lines. This

(continued overleaf)

extra-bright line in the video signal is easily separated from the composite video signal and is used for guidance purposes. In operation, the composite video signal from the TV camera is first routed to TV (video viewing) and waveform monitors and then to a blanking circuit to remove unwanted portions of the signal. Next, the signal is amplified to raise its voltage and power to a level that can be used by the logic section. Logic circuits then separate the video information from the synchronizing pulses to control a binary counter. Because of the control in the logic circuit, the counter will begin counting at the top of the TV field and will then count each successive horizontal line (1, 2, 3 . . . ) until the bright line caused by the weld seam illumination is sensed. Appearance of the bright line stops the counter on that horizontal line number. This number is then stored in a flip-flop register and the counter is reset for operation during the scanning of the next TV field. The stored horizontal line number in the register is fed to a digital-to-analog (D-A) converter which converts the number to a proportional dc voltage. This voltage representation of the stored number is then algebraically summed in the comparator with a reference voltage. The latter can be manually set to a level corresponding to any scan line position desired; however, it is usually set to a level near the center of the field of view. If the dc output voltage of the D-A converter is either less than or greater than the reference dc voltage, the difference between the two voltages will be a plus or minus dc error signal to the torch-positioning servo amplifier. An error signal to the servo amplifier causes it to drive the motor in a direction that will move the camera-torch carriage along the X axis. Polarity of the error signal to the servo amplifier determines the direction and the distance that the camera-torch carriage will move until the error difference is nulled.

New error information is received much more rapidly than the carriage can move, because the counter is counting and supplying new tracking data each time a TV field is scanned. Since the TV field is scanned 60 times per second, the counter will supply new tracking data each 1/60th of a second. A continuous and rapid supply of position information allows the servo system to guide the welding arc along the weld centerline.

**Notes:**

1. The system is being developed to track (1) highly irregular weld seams without tack welds, (2) moderately irregular seams with tack welds, and (3) butt joints, overlap joints, or tee joints.
2. The surface condition of the workpieces (bright, dull, painted, rusty, etc.) generally has no effect on the operation; however, some joint preparation is necessary to assure success.
3. Complete details may be obtained from:  
Technology Utilization Officer  
Marshall Space Flight Center  
Huntsville, Alabama 35812  
Reference: B68-10357

**Patent status:**

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